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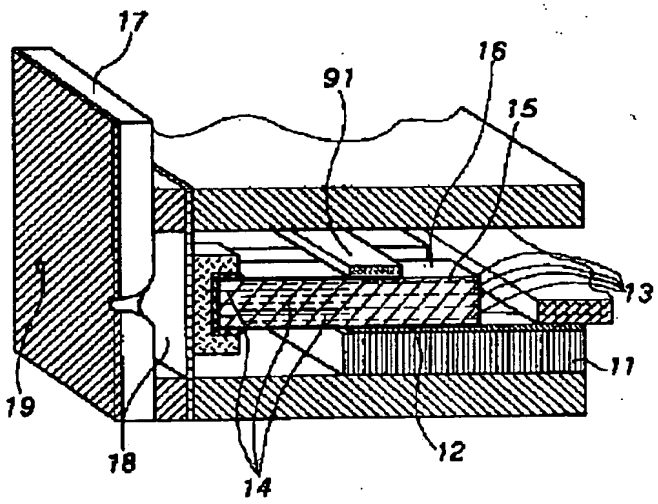
TITLE : INK JET-TYPE PRINT HEAD



ABSTRACT : PURPOSE: To provide a highly reliable, miniaturizable ink jet-type print head, in which migration occurs hardly.

CONSTITUTION: In the present device, piezoelectric element made up by laminating piezoelectric materials 15 and conductive laminae a form a plural sandwich form. The conductive laminae 14 and 13 used here are such that the lamina on each one of or on both of the plus-side and the minus-side are applied with patterning which is formed to correspond to a nozzle 19.

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] It is the ink-jet formula print head characterized by having the structure which nozzle opening is made to correspond, the piezoelectric device has been arranged, and the aforementioned piezoelectric device carried out two or more sheets laminating of piezoelectric material and the electric conduction layer for a piezoelectric-material drive which carried out patterning to the configuration corresponding to nozzle opening by turns in the ink-jet formula print head which makes ink breathe out by the driving signal to a piezoelectric device, and carried out the manipulation array in the pitch corresponding to the aforementioned nozzle opening.
[Claim 2] The ink-jet formula print head according to claim 1 characterized by carrying out patterning of any or one side to the configuration corresponding to nozzle opening the plus [of the electric conduction layer for a drive of a laminating type piezoelectric device], and minus side.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] this invention relates to the print head used for an ink jet printer.
[0002]
[Description of the Prior Art] The conventional ink-jet formula print head makes the flexible orientation in agreement, arranges a piezoelectric device and is constituted so that it may counter with each nozzle opening while two or more nozzle openings are formed in the wall surface of the container which constitutes an ink tank, as shown in JP,60-8953,B. This print head impresses a driving signal to a piezoelectric device, makes a piezoelectric device expand and contract, makes an ink drop breathe out from nozzle opening with the dynamic pressure of the ink generated at this time, and forms a dot in a print sheet.
[0003] In the print head of such a format, it is desirable that the formation luminous efficacy and the flight force of a drop are large. However, extremely, for a parvus reason, it is necessary to impress a high voltage for acquiring the flight force required of a printing, and the unit length of a piezoelectric device and the degree of shrinkage per unit voltage have the problem that a drive circuit and the cure against an electric insulation are complicated in it.
[0004] In order to solve such a problem, the piezoelectric device for ink-jet print heads which carried out the laminating of an electrode and the piezoelectric material to the shape of sandwiches by turns, and carried out simultaneous sintering is proposed as shown in JP,63-295269,A. Since inter-electrode distance can be made small as much as possible according to this piezoelectric device, it is effective in the ability to lower the voltage of a driving signal.
[0005]
[Problem(s) to be Solved by the Invention] However, when it carried out the slice manipulation of the piezoelectric device in order for many of electrical conducting materials such inside a piezoelectric device to realize a miniaturization since Ag/Pd was used, it made the electrical conducting material exposed to a manipulation cross section, and had become the factor which Ag migration occurs in the piezoelectric-device surface section, and reduces a reliability. Although it is the most effective means not to use Ag for an electrical conducting material in order to avoid this problem, the modality of electrical conducting material which can be chosen for the following grounds is limited to Ag/Pd.
[0006] 1. In the thick-film simultaneous sintering process which calcinates piezoelectric material and an electrical conducting material simultaneously, since piezoelectric material is sintered at oxidization kiln, an electrical conducting material will also oxidize.
[0007] 2. If the sintering temperature of piezoelectric material is higher than the melting point of an electrical conducting material, an electrical conducting material will be spread in piezoelectric material, and will lead to a degradation of insulation resistance, and deformation of a piezoelectric device.
[0008] The electrical conducting material seldom oxidized and was limited to Ag/Pd with the high melting point by the above.
[0009] Moreover, the stack type actuator currently used from the former was difficult to miniaturize.
[0010] The place which this invention was made in view of such a problem, and is made into the purpose is reliable, and it is in offering the ink-jet formula print head using the piezoelectric device which can be miniaturized easily.
[0011]
[Means for Solving the Problem] The piezoelectric device for solving the above-mentioned technical probrem to this invention The plus side which carried out patterning to piezoelectric material and the configuration corresponding to nozzle opening, About the electric conduction layer by the side of minus, it is a piezoelectric-material -> plus side (minus side) electric conduction layer -> piezoelectric-material -> minus side (plus side) electric conduction layer -> piezoelectric-material -> plus side (minus side) electric conduction layer.... It is the laminating type piezoelectric device which carried out two or more sheets laminating to -> piezoelectric material. The aforementioned laminating type piezoelectric device is characterized by having the structure which carried out the manipulation array in the pitch corresponding to the aforementioned nozzle opening. Furthermore, any of a minus side electric conduction layer or one side is characterized by carrying out patterning to the configuration corresponding to nozzle opening the plus side of a laminating type piezoelectric device.
[0012]
[Example] One example of the ink-jet formula print head in this invention is shown in drawing 1 . In drawing 1 , 11 is the plate (a nozzle plate is called hereafter.) in which in an electric conduction layer and 15 piezoelectric material and 16 formed the laminating type piezoelectric device in, and 17 formed [adhesives, and 13 and 14 / a pedestal and 12] the nozzle, and 18 is ink passage.

[0013] Drawing 2 **** view 9 explains the manufacture process of the head of this invention, and it explains a view to a basis below.
[0014] (The 1st process) The piezoelectric material 15 of the shape of a green sheet, such as a titanic-acid lead zirconate system compound perovskite ceramic, is first formed with a doctor blade method, an extrusion process, etc. Next, as shown in drawing 2 , the plus side (minus side) electric conduction layer 13 is formed in the top of piezoelectric material 15 with a screen printing etc. in the pitch corresponding to nozzle opening. Drawing of longitudinal section and (c of the plan in which (ain drawing 2) shows the formation status by the 1st process, and (b)) are cross-sectional views. (The 2nd process) Further, as shown in drawing 3 , piezoelectric material 15 is formed in the top, and the minus side (plus side) electric conduction layer 14 is further formed in the top. Drawing of longitudinal section and (c of the plan in which (ain drawing 3) shows the formation status by the 2nd process, and (b)) are cross-sectional views.
[0015] (The 3rd process) the same -- carrying out -- 15, 13, 15, 14, 15, 13, and ..... after carrying out a laminating to 15, the piezoelectric device of the laminated structure shown in drawing 4 is obtained by calcinating Drawing of longitudinal section and (c of the plan in which (ain drawing 4) shows the formation status by the 3rd process, and (b)) are cross-sectional views.
[0016] (The 4th process) In order to pull out the electric conduction layers 13 and 14 outside after that, as shown in drawing 5 , the electric conduction layer 52 is used for both ends 51, the thin film technique, such as a spatter and vacuum evaporationo, and the thick-film technique, such as screen-stencil, are formed in them, and the laminating type piezoelectric device 16 is obtained. The plan in which (ain drawing 5) shows the formation status by the 4th process, and (b) are drawings of longitudinal section.
[0017] (The 5th process) As shown in drawing 6 , the laminating type piezoelectric device 16 manufactured as mentioned above is fixed using adhesives 71, as the individual electrode 61 is shown in drawing 7 on the formed pedestal 11. The plan showing the pedestal 11 in which (ain drawing 6) formed the individual electrode 61, and (b) are drawings of longitudinal section, and the plan in which (ain drawing 7) shows the formation status by the 5th process, and (b) are drawings of longitudinal section.
[0018] (The 6th process) It does in this way, and the fixed piezoelectric device 16 puts in an infeed finely in an individual electrode pitch and this pitch by the peripheral cutting edge of the aforementioned bonded abrasive, and the cutting technique by the loose grain, as shown in drawing 8 . Here, if it is the width of face W1 of remnants width-of-face W of a piezoelectric device, and the electric conduction layers 13 and 14, it is necessary to perform a cutting so that it may be set to 1+60-100 micrometers of W=W, and to make it the structure which the electric conduction layers 13 and 14 do not expose to a cutting cross section.
[0019] Then, the piezoelectric-device train 81 containing the individual electrode 61 and the infeed is connected. Since it is necessary to connect electrically the individual electrode 61 formed on the electric conduction layer 52 and the pedestal 11, as for adhesives here, it is the optimum to use the electric conduction pastes 82, such as solder and an electroconductive glue. The plan in which (ain drawing 8) shows the formation status by the 6th process, and (b) are drawings of longitudinal section.
[0020] (The 7th process) Next, as shown in drawing 9 , the common electrode 91 is connected, and the periphery of a piezoelectric device is protected by the moisture resistant material etc. so that it may prevent further that ink flows in for the enhancement in a reliability. In order to remove that the foam goes into a moisture resistant material here, it is desirable to process a vacuum degassing etc. The plan in which (ain drawing 9) shows the formation status by the 7th process, and (b) are drawings of longitudinal section.
[0021] Next, ink passage and a nozzle plate are formed and, as a result, the head structure shown in drawing 1 is acquired.
[0022] Next, the result which carried out insulation resistance evaluation in the head of this invention is described. Drawing 10 is drawing showing the configuration of the laminating type piezoelectric device which carries out patterning of the electric conduction layer, and the electric conduction layer has not exposed to a surface made as an experiment to evaluation based on the above-mentioned process, (a) is the plan and (b) is a vertical (A-A') cross section. Drawing 11 is drawing showing the configuration of the laminating type piezoelectric device which the electric conduction layer exposed to the conventional surface, (a) is the plan and (b) is drawing of longitudinal section. A specification is as follows.
[0023] (Trial production specification)
- Thick ******** specification thickness t 1= 30 (mum)
Piezoelectric constant d 31= 300x10-12 (m/V)
Mechanical-component length 103 la=3.7 (mm)
- Electric conduction layer specification electric conduction layer material Ag/Pd=80/20 WT.% electric conduction bed depth t 2= 2 (mum)
(Evaluation conditions)
- Content of evaluation The insulation resistance degradation evaluation and conditions in a high-humidity/temperature drive examination Temperature of 60 degrees C 90% R.H driver voltage of humidity DC30V view 12 is drawing showing an evaluation result. According to the evaluation result of drawing 12 , the mode of an insulation resistance degradation is divided into two of the following.
[0024] Mode ** ... Mode mode ** which insulation resistance falls temporarily and returns again ... Both ** and ** have generated the degradation mode of the laminating type piezoelectric device of the structure which the electric conduction layer has exposed to the conventional manipulation cross-section section to the degradation mode of the laminating type piezoelectric device of this invention which the electric conduction layer has not exposed being only ** from the manipulation cross-section section of the mode laminating type piezoelectric device to which insulation resistance falls and does not return with time. The drawing 13 and the drawing 14 are drawings explaining the cause of occurrence of this degradation mode ** and **, and explain the ground for occurrence in each mode on the basis of drawing.
[0025] (Ground for occurrence of mode **) porous one inside [which is generated as byroads, such as organic gas, at the time of

piezoelectric-device sintering as shown in view 13] PZT -- Ag migration grows along with 131 and a plus side electric conduction layer and a minus side electric conduction layer are short-circuited However, usually, since porous one of this is very minute, it is thought that the grown-up migration can be burned off immediately after the shunt.
[0026] (Ground for occurrence of mode **) As shown in view 14 , the Ag migration 141 grows the piezoelectric-device surface section, a plus side electric conduction layer and a minus side electric conduction layer are short-circuited, and a laminating type piezoelectric device is destroyed. The shunt here can consider simplistic [in the same minute fraction as mode **], and the shunt in a comparatively large fraction. Conventionally, since the electric conduction layer of a manipulation cross section is in contact with the open air, especially laminating type PZT of structure tends to be influenced of surface contamination, humidity, etc., and migration 141 is considered that insulation resistance also deteriorates with time and goes according to it in order to grow up to be also longitudinal direction with time (it becomes thick).
[0027] Here, a breakdown of the laminating type piezoelectric device of mode ** poses a problem as a piezoelectric device used for an ink-jet formula print head, and it is checked that there is no failure of mode ** on an ink regurgitation property a problem.
[0028] Drawing 15 is drawing showing another example of this invention, (a) is the plan and (b) is drawing of longitudinal section. Patterning of one of the electric conduction layers of a plus side electric conduction layer or a minus side electric conduction layer is carried out, and it is made the structure where only one of the two's electrode is not exposed to a manipulation cross section. Also in such structure, the reliability equivalent to the laminating type piezoelectric device of drawing 10 was securable. Since this is the phenomenon in which Ag migration is a kind of electrolytic action, and Ag is eluted when a direct current is impressed to the moisture in the atmospheric air, and Ag inter-electrode, and grow up, and insulation resistance falls, if one electrode is protected, it will be thought that the current has secured the reliability to inter-electrode by not flowing.
[0029] Since this structure does not have the need of carrying out position doubling of a plus side electric conduction layer and a minus side electric conduction layer, as compared with the structure of drawing 10 , it can secure the laminating type piezoelectric device excellent in mass-production nature. Moreover, 60-100 micrometers of many remnants width-of-face W of a piezoelectric device are taken in drawing 8 for 30-50 micrometers of the thickness t3 of the protection layer of an electric conduction layer being required to the width of face W1 of the electric conduction layers 13 and 14. Drawing 16 is drawing showing the result which conducted the optimization experiment of the protection bed depth t3. Although according to this result the reliability improved rather than the structure which the conventional electric conduction layer exposed when t3 was about 10-20 micrometers, the degradation of insulation resistance with time was not avoided. However, if t3 is thickened with 30-50 micrometers, it does not generate but a degradation of insulation resistance with time can secure a good reliability.
[0030] Here, like the following formulas, amount [of displacement] delta of a laminating type piezoelectric device is proportional to voltage V, mechanical-component length la, and the piezoelectric constant d31, and is in inverse proportion to thickness t.
When the specification of a trial production piezoelectric device is substituted for the above-mentioned formula delta=d31, la and V / now [t] and the amount of displacement at the time of voltage 30V impression is computed, it is delta=300x10-12 and 3.7x10-3.30/(30x10-6).
= 1.11x10-6 (m)
Although it should become, since the manipulation cross section of the laminating type piezoelectric device of this invention becomes the structure covered with PZT material with high Young's modulus, at the time of 3= 30-50 micrometers of t, amount of displacement] delta is suppressed about 20%, and it will be set to delta**0.9. In order to obtain an equivalent variation rate for this reason, it is necessary to enlarge the mechanical-component length la or driver-voltage V 20%. Moreover, it is necessary to choose the minimum thickness t3 which can secure a reliability, and since a correlation (the amount of displacement will decrease if t3 becomes thick.) is in the thickness and the amount of displacement of t3, the value is 3= 30-50 micrometers of t, as explained above.
[0031]
[Effect of the Invention] A piezoelectric-material side, a plus-in configuration corresponding to nozzle opening in piezoelectric device in this invention side, It is a piezoelectric-material -> plus side (minus side) electric conduction layer -> piezoelectric-material -> minus side (plus side) electric conduction layer -> piezoelectric-material -> plus side (minus side) electric conduction layer about the electric conduction layer which carried out patterning of the electric conduction layer by the side of minus.... It is the laminating type piezoelectric device which carried out two or more sheets laminating to -> piezoelectric material. the aforementioned laminating type piezoelectric device The manipulation array was carried out in the pitch corresponding to the aforementioned nozzle opening, and it was made the structure which an electric conduction layer does not expose to a manipulation cross section. By having carried this in the ink-jet head, the ink-jet formula print head which can miniaturize the high-reliability which migration seldom generates is realizable. Moreover, by carrying out patterning only of one of the electric conduction layers by the side of a plus or minus, position doubling of a plus side electric conduction layer and a minus side electric conduction layer became easy, and the head excellent in mass-production nature has been realized.

[Translation done.]

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TECHNICAL FIELD

[Field of the Invention] this invention relates to the print head used for an ink jet printer.

[Translation done.]

PRIOR ART

[Description of the Prior Art] The conventional ink-jet formula print head makes the flexible orientation in agreement, arranges a piezoelectric device and is constituted so that it may counter with each nozzle opening while two or more nozzle openings are formed in the wall surface of the container which constitutes an ink tank, as shown in JP,60-8953,B. This print head impresses a driving signal to a piezoelectric device, makes a piezoelectric device expand and contract, makes an ink drop breathe out from nozzle opening with the dynamic pressure of the ink generated at this time, and forms a dot in a print sheet.

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TECHNICAL PROBLEM

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MEANS

[Means for Solving the Problem] The piezoelectric device for solving the above-mentioned technical probrem to this invention The plus side which carried out patterning to piezoelectric material and the configuration corresponding to nozzle opening, About the electric conduction layer by the side of minus, it is a piezoelectric-material -> plus side (minus side) electric conduction layer -> piezoelectric-material -> minus side (plus side) electric conduction layer -> piezoelectric-material -> plus side (minus side) electric conduction layer.... It is the laminating type piezoelectric device which carried out two or more sheets laminating to -> piezoelectric material. The aforementioned laminating type piezoelectric device is characterized by having the structure which carried out the manipulation array in the pitch corresponding to the aforementioned nozzle opening. Furthermore, any of a minus side electric conduction layer or one side is characterized by carrying out patterning to the configuration corresponding to nozzle opening the plus side of a laminating type piezoelectric device.

[Translation done.]